PCT/AU98/00298

REC'D 15 MAY 1998
WIPO PCT

5

Patent Office
Canberra

I, KIM MARSHALL , MANAGER EXAMINATION SUPPORT AND SALES, hereby certify that the annexed are true copies of the Provisional specification in connection with Application No. PP 2742 for a patent by UNISEARCH LIMITED filed on 1 April 1998.

I further certify that the annexed specification is not, as yet, open to public inspection.

PRIORITY DOCUMENT

COMMONWEALTH OF AUSTRALIA
AUSTRALIA
PATENT OFFICE

WITNESS my hand this First day of May 1998

KIM MARSHALL
MANAGER EXAMINATION SUPPORT AND SALES

P/00/009
Regulation 3.2

AUSTRALIA
Patents Act 1990

PROVISIONAL SPECIFICATION

FOR THE INVENTION ENTITLED:

"OIL FROM WATER SEPARATOR"

Applicant:

UNISEARCH LIMITED

AUSTRALIAN
PROVISIONAL No. DATE OF FILING
PP2742 - 1 APR. 98
PATENT OFFICE

The invention is described in the following statement:

OIL FROM WATER SEPARATOR

The present application relates to oil from water separators and, more particularly, such separators suitable for use in inground or aboveground installations where it is desired to prevent oil in water concentrations above a predetermined limit from being distributed to the environment in an uncontrolled fashion.

BACKGROUND

Mechanical oil from water separator systems are known. Devices/systems are also known that provide settling in chambers separated by baffles - refer the arrangement of Fig. 1 which shows a Prior Art American Petroleum Institute (API) oil from water separator design. It consists of a rectangular tank with two or more vertical partitions to separate entry chamber, oil disengagement chamber and effluent water chamber, and which is designed to run full of water.

The API oil from water separator is sized to provide low turbulence conditions and sufficient residence time for oil globules with a minimum diameter of 0.015 cm (150 microns) to separate from the oil/water mixture flowing though the separator.

This prior art system can be characterised as a decant-type system where for every input of liquid there is an output of a similar amount at the same time, thereby affecting separation efficiency.

It is an object of the present invention to provide an arrangement which improves the performance of such a basic arrangement.

BRIEF DESCRIPTION OF INVENTION

Accordingly, in one broad form of the invention there is provided an oil from water separator including an oil disengagement chamber adapted to receive an oil and water mixture and retain it for a sufficient time in a relatively undisturbed state whereby oil in the mixture floats to the top of the mixture resulting in a substantially oil free volume of water having a layer of oil derived from said oil and water mixture floating on the surface thereof; characterised in that outflow from said chamber controlled to a predetermined rate by flow retarding means.

In a further broad form of the invention there is provided an oil from water separator including an oil disengagement chamber adapted to receive an oil and water mixture and retain it for an extended time in a relatively undisturbed state whereby oil in the mixture floats to the top of the mixture resulting in a substantially oil free volume of water having a layer of oil derived from said oil and water mixture floating on the surface thereof; characterised in that outflow from said chamber is controlled in a predetermined way by flow retarding means.

In a further broad form of the invention there is provided an oil from water separation system including an oil

disengagement chamber having a flush storage volume defined between a chamber high liquid level and a chamber low liquid level; said flush storage volume caused to exit from said chamber on attainment of said chamber high liquid level.

Preferably said flush storage volume is caused to exit by means of a siphon mechanism.

In a further broad form of the invention there is provided an oil from water separator including an oil disengagement chamber adapted to receive an oil/water mixture and retain it for a sufficient time in a relatively undisturbed state whereby oil in the mixture floats to the top of the mixture resulting in a substantially oil free volume of water having a layer of oil derived from said oil and water mixture floating on the surface thereof; characterised in that outflow from said chamber is prevented until said mixture reaches a predetermined chamber high liquid level whereupon said volume of water is caused to exit said chamber.

In a further broad form of the invention there is provided an oil from water separator including an oil disengagement chamber adapted to receive an oil/water mixture and retain it for a sufficient time in a relatively undisturbed state whereby oil in the mixture floats to the top of the mixture resulting in a substantially oil free volume of water having a layer of oil derived from said oil and water mixture floating on the surface thereof; characterised in that outflow from said chamber is limited by flow retarding

means to a predetermined function of the level of said oil and water mixture in said chamber.

Preferably said flow retarding means is operable only between a chamber low liquid level and a chamber high liquid level.

In one particular preferred form said flow retarding means comprises at least one siphon which cuts in at said chamber high liquid level and cuts out at said chamber low liquid level.

In an alternative preferred form said flow retarding means comprises at least one bleed aperture or weep hole.

Preferably said at least one bleed aperture or weep hole is located at the level of said chamber low liquid level.

More preferably said at least one bleed aperture or weep hole is sized with reference to expected inflow of said oil and water mixture into said oil disengagement chamber such that, during operation, the level of said oil and water mixture will rise from said chamber low liquid level up to said chamber high liquid level and then return to said chamber low liquid level, thereby defining an oil and water mixture active lag volume between said chamber low liquid level and said chamber high liquid level.

More preferably said active lag volume has a characteristic which is a function of

(a) inflow rate

(b) desired residence time of said oil and water mixture in said oil disengagement chamber.

BRIEF DESCRIPTIONS OF THE DRAWINGS

Embodiments of the invention will now be described with reference to the accompanying drawings wherein: -

Fig 1 illustrates a Prior Art (API) separator and

Fig 2 illustrates a separator system according to a first embodiment of the system.

Fig. 3 illustrates the sequence of filling and emptying of the separator system of Fig. 2.

Fig.4 is a graph of head versus flow for the separator system of Fig. 2,

Fig. 5 illustrates in cross section a separator system according to a second embodiment of the invention together with a graph of head versus flow for that system,

Fig. 6 illustrates, in cross section, a separator system according to a third embodiment of the invention involving multiple weep holes together with a graph of head versus flow for that system,

Fig. 7 is a graph of the behaviour of water level in the system of Fig. 2 in the form of a graph of water level versus time,

Fig. 8 illustrates the behaviour of the system of Fig. 2 under alternative operating conditions in the form of a graph of water level versus time,

Fig. 9 illustrates the behaviour of the system of Fig. 5 in the form of a graph of water level versus time,

Fig. 10 illustrates particular flow characteristics of particular implementations of the invention (example 2) and

Fig. 11 is a top view and side section view of an alternative particular implementation (example 3) of the system of the invention.

Fig. 12 is an indicative diagram of the active lag volume operable above a predefined liquid low level in an separator system according to the first, second or third embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The Prior Art separator (10) of Fig 1 comprises an entry chamber (11) separated by a baffle (12) from an oil disengagement chamber (13) which, in turn, is separated from an effluent water chamber (15) by a barrier (14).

Various embodiments of the invention as to be described below are characterised in their most broad form by the addition of a flow retarding device to an outlet portion of a storage volume. The storage volume can be in the form of the prior art API separator of Fig. 1 or could take an alternative form (for example refer example 3 of Fig. 11 to be described later in this specification).

The flow retarding device acts to ensure that for the majority of operating conditions likely to be encountered, liquid in the storage volume will have a sufficient residence

time to ensure oil from water separation substantially to a predetermined value.

In some of the embodiments described below the flow retarding device operates on an intermittent basis. In other embodiments it operates on a continuous basis, although there may be discontinuities in the flow characteristic.

In all cases, the flow retarding device operates when liquid in the storage volume has a level lying between a defined liquid low level and a defined liquid high level.

Furthermore, it imposes an outflow rate from the storage volume which is a function of the liquid level in the storage volume, at least when it lies between the defined liquid low level and defined liquid high level.

FIRST EMBODIMENT

With reference to Fig 2 an oil from water separator system (20) according to a first embodiment of the invention is illustrated.

Fig. 3 shows a series of operating conditions A - E for the separator of Fig. 2.

The system (20) directs an influent of oily water through a baffle (12) to an oil disengagement chamber (21) the water from which passes beneath a skimmer wall or second baffle 14 to a siphon pipe (22) in an end wall (16). This siphon pipe (22) connects to a draw off tank (23) which, in turn, allows exit of liquid above a predetermined level (24) via exit pipe (25).

The siphon pipe (22), in operation, causes the level of liquid in oil disengagement chamber (21) to move between high level (27) and low level (28).

The volume of liquid defined between these two levels is designated the flush storage volume (29).

In use water laden with oil enters oil disengagement chamber (21) as in A of Fig 3 with the level in tank (21) rising until flush storage volume (29) is achieved at which time siphon pipe (22) operates to cause the flush storage volume (29) to exit into draw off tank (23) until the siphon breaks at low level (28). Low level (28) is selected to be, for design conditions, such that accumulated, separated oil cannot pass under the skimmer wall (14) and escape from the separator.

As more oil laden water enters oil disengagement chamber (21) the process repeats itself in accordance with Fig 3 C, D, E.

In this manner a relatively large volume of oil/water mixture is retained for a relatively long period of time to allow oil separation to occur prior to siphoned exit.

Restated in other terms: A feature of this embodiment is the incorporation of one or more automatic siphons which release water only periodically from an oil disengagement chamber and which chamber creates a potential storage for a selected volume of first flush oil/water mixture or a major

oil spillage of a volume equal to the flush storage volume (29).

This volume (29) is sized to contain a major oil spillage or to be filled progressively with oil/water mixture from successive rainfall events. Until this volume (29) is accumulated, oil globules can coalesce and separate from the water over a period much greater than the residence time available in the standard through-flow separator of Fig. 1. The oil disengagement chamber (21) is quiescent with virtually zero turbulence except at the end of each cycle when the siphon is operating.

When the water surface reaches a selected chamber high liquid level (27) a siphon in the effluent water chamber (23) is primed and substantially oil-free water is released until the water surface falls to a selected chamber low liquid level (28) at which the siphon breaks. This release of water creates the flush storage volume (29) for the next cycle of oil/water inflows.

Fig. 4 illustrates a head versus flow characteristic for the siphon arrangement of the first embodiment of Fig. 2.

SECOND EMBODIMENT

Fig. 5 illustrates a second embodiment of the invention (in cross section) comprising a flow retarding device 30 on the outlet side of a storage volume 31. In this instance the flow retarding device 30 comprises a retention wall 32 having a bleed aperture 33 (also termed a weep hole) therewithin

which will permit the gradual release of liquid in storage volume 31 above a predetermined level 34. The head versus flow characteristics for this arrangement are also shown in Fig. 5.

THIRD EMBODIMENT

An alternative arrangement of the system of the invention according to a third embodiment is illustrated in cross section in Fig. 6 and comprises, in this instance, a retention wall 42 on an outlet side of storage volume 41 having within it a first bleed aperture 43, a second bleed aperture 44 and a third bleed aperture 45 located at respective predetermined levels 46, 47, 48.

Fig. 6 also shows a graph of head versus flow for this multiple weep hole embodiment of the flow retarding device 40.

Broadly it will be observed that the first embodiment of Fig. 2 utilises a siphon to achieve controlled flow retardation whilst the second and third embodiments utilise weep holes.

Whereas water will not start to flow through a siphon until a priming level is reached and will continue to flow until the water surface reaches some lower level, water will flow through a hole only when the hole is submerged.

The objective of controlling the release of water from an oil from water separator is to provide residence time in the separator during which the desired separation of oil droplets from the water can occur.

The siphon achieves this residence time by storing incoming water until the provided capacity is full, when the relatively oil-free water is released and the cycle starts again.

In some applications of a disengagement chamber for oil from water separation, the load may be regular as in daily washdowns and in these applications a slow drawdown overnight may be more desirable than the siphon characteristic.

Such an alternative characteristic could be achieved by replacing the siphon with weep holes, varying their number, sizes and locations to achieve any desired outflow/level relationship. This allows the water surface in the separator to return slowly to the bottom operating level without first reaching some top operating level but after a sufficient time for oil from water separation.

The relationship between separator water level and outflow for a siphon and one or more weep holes is illustrated in Figures 4, 5 and 6 as earlier described.

The movement in separator water level during an inflow event, however, will be broadly similar for the siphon and the weep holes, at least as far as achieved residence time is concerned. With some generality it can be asserted that:

- An effective separator design will not require a cycle time (from rising above the bottom operating level to returning to it) of more than 12-24 hours

- For rainfall runoff typical of a 1 in 1 year event, the separator could fill to the top operating level in less than an hour
- The initial rise of the separator water level will be steep compared with the exponential fall after the outflow through the weep holes or the siphon (see Figure 2)
- The earlier release of water through a weep hole than could occur with a siphon not yet at its priming level would have negligible effect on the initial rise in water level
- During water level fall from the top operating level, the flow through both the weep hole and the siphon would decline exponentially as a function of head above the outlet
- If the inflow event was not large enough to prime the siphon, the water would remain in the separator until there was sufficient water; with a weep hole, the water outflow would continue to decline exponentially until the weep hole level was reached, still providing (by design) the desired residence time.

The examples of the various embodiments will now be given:

EXAMPLE 1

An API type rectangular tank with siphon installed in the exit wall. Typical dimensions (eg. for Nelson Bay) were 7m

long, 1.5m wide and siphon operating levels 1.6m and 0.8m above the floor. Volume = approx 17KL, about half of which is the range between siphon operating levels. The siphon is made of 18mm OD hard drawn copper pipe and takes about 10 hours to draw the water level down.

EXAMPLE 2

Fig. 10 illustrates a particular example of head versus flow behaviour for the siphon embodiment of Fig. 2, the single weep hole embodiment of Fig. 5 and the multiple weep hole embodiment of Fig. 6.

EXAMPLE 3

Fig. 11 illustrates an alternative storage volume arrangement which, as seen in plan view, takes the form of a doughnut-shaped tank with inflow to a central distributor in the form of a stand pipe 51.

Outflow is from a circular retention wall 52. Controlled outflow is achieved either via a siphon pipe 53 to clarified water outlet 54 or via bleed apertures (not shown) in retention wall 52.

For this example dimensions of the siphon pipe and/or the bleed apertures can be as for either example 1 or example 2 respectively.

With reference to Fig. 12 the previously described first, second and third embodiments can be seen to all incorporate an active lag volume 60 which operates above a predefined liquid low level 61 and can extend as high as a predefined liquid high level 62.

The active lag volume 60 comes into operation when inflow to the oil disengagement chamber is such that the liquid level rises above liquid low level 61.

Liquid low level 61 has associated with it, in these examples, either the lower end of a siphon or at least one weep hole sized in the manner previously described and which, in combination with the barrier 63, forms a flow retarding means which controls the shape and characteristic of the active lag volume 60.

The active lag volume has a characteristic which assists in efficient oil from water separation such that, for a predefined range of inflows, outflow will contain a proportion of oil in water substantially below a predefined limit.

The above describes only some embodiments of the present invention and modifications obvious to those skilled in the art can be made thereto without departing from the scope and spirit of the present invention.

It is expected that, in many embodiments, operation of the oil from water separator system should be unattended and/or automatic.

CLAIMS

1. An oil from water separation system including an oil disengagement chamber having a flush storage volume defined between a chamber high liquid level and a chamber low liquid level; said flush storage volume caused to exit from said chamber on attainment of said chamber high liquid level.

2. The system of Claim 1 wherein said flush storage volume is caused to exit by means of a siphon mechanism.

3. An oil from water separator including an oil disengagement chamber adapted to receive an oil and water mixture and retain it for a sufficient time in a relatively undisturbed state whereby oil in the mixture floats to the top of the mixture resulting in a substantially oil free volume of water having a layer of oil derived from said oil and water mixture floating on the surface thereof; characterised in that outflow from said chamber is prevented until said mixture reaches a predetermined chamber high liquid level whereupon said volume of water is caused to exit said chamber.

4. The separator of Claim 3 wherein, on reaching said chamber high liquid level, outflow is initiated and maintained until a predetermined chamber low liquid level in said chamber is reached at which time outflow is terminated.

5. The separator of Claim 3 or Claim 4 wherein said outflow is controlled by means sensitive to said chamber high liquid level and said chamber low liquid level.

6. The separator of any one of Claims 3-5 wherein said outflow is drawn from a point at said predetermined low level in said mixture.

7. The separator of Claim 5 or Claim 6 wherein said means sensitive to said chamber high liquid level and said chamber low liquid level is a siphon.

8. The separator of Claim 5 or Claim 6 wherein said means sensitive is a level switch actuated pumping system.

9. An oil from water separator including an oil disengagement chamber adapted to receive an oil and water mixture and retain it for a sufficient time in a relatively undisturbed state whereby oil in the mixture floats to the top of the mixture resulting in a substantially oil free volume of water having a layer of oil derived from said oil and water mixture floating on the surface thereof; characterised in that outflow from said chamber controlled to a predetermined rate by flow retarding means.

10. The separator of claim 9 wherein said flow retarding means operates so that outflow is prevented until said mixture reaches a predetermined chamber high liquid level whereupon said volume of water is caused to exit said chamber.

11. The separator of Claim 10 wherein, on reaching said chamber high liquid level, outflow is initiated and maintained until a predetermined chamber low liquid level in said chamber is reached at which time outflow is terminated.

12. The separator of Claim 10 or Claim 11 wherein said outflow is controlled by means sensitive to said chamber high liquid level and said chamber low liquid level.

13. The separator of any one of Claims 10-12 wherein said outflow is drawn from a point at said predetermined low level in said mixture.

14. The separator of Claim 12 or Claim 13 wherein said means sensitive to said chamber high liquid level and said chamber low liquid level is a siphon.

15. The separator of Claim 12 or Claim 13 wherein said means sensitive is a level switch actuated pumping system.

16. The separator of claim 10 wherein said flow retarding means comprises a retention wall having at least one aperture at a predetermined level passing therethrough; said at least one aperture adapted to regulate flow of water from said disengagement chamber when said mixture is above said predetermined level.

17. An oil from water separator including an oil disengagement chamber adapted to receive an oil and water mixture and retain it for an extended time in a relatively undisturbed state whereby oil in the mixture floats to the top of the mixture resulting in a substantially oil free volume of water having a layer of oil derived from said oil and water mixture floating on the surface thereof; characterised in that outflow from said chamber is controlled in a predetermined way by flow retarding means.

18. An oil from water separator including an oil disengagement chamber adapted to receive an oil/water mixture and retain it for a sufficient time in a relatively undisturbed state whereby oil in the mixture floats to the top of the mixture resulting in a substantially oil free volume of water having a layer of oil derived from said oil and water mixture floating on the surface thereof; characterised in that outflow from said chamber is limited by flow retarding means to a predetermined function of the level of said oil and water mixture in said chamber.

19. The separator of claim 17 or claim 18 wherein said flow retarding means is operable only between a chamber low liquid level and a chamber high liquid level.

20. The separator of claim 19 wherein said flow retarding means comprises at least one siphon which cuts in at said chamber high liquid level and cuts out at said chamber low liquid level.

21. The separator of claim 19 wherein said flow retarding means comprises at least one bleed aperture or weep hole.

22. The separator of claim 21 wherein said at least one bleed aperture or weep hole is located at the level of said chamber low liquid level.

23. The separator of claim 19 wherein said flow retarding means is sized with reference to expected inflow of said oil and water mixture into said oil disengagement chamber such that, during operation, the level of said oil and water

mixture will rise from said chamber low liquid level up to said chamber high liquid level and then return to said chamber low liquid level, thereby defining an oil and water mixture active lag volume between said chamber low liquid level and said chamber high liquid level.

24. The separator of claim 23 wherein said active lag volume has a characteristic which is a function of

(a) inflow rate and

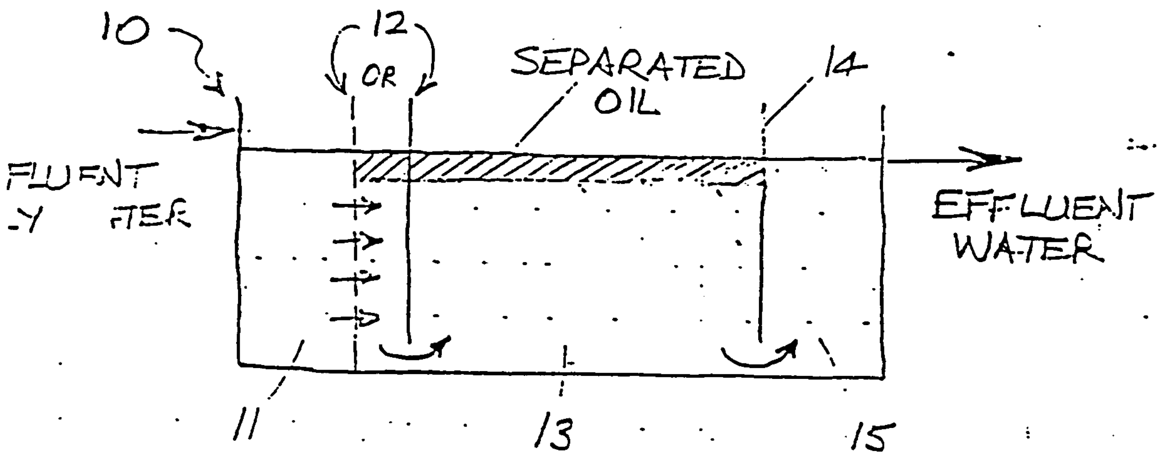
(b) desired residence time of said oil and water mixture in said oil disengagement chamber.

DATED: 1 April 1998

CARTER SMITH & BEADLE

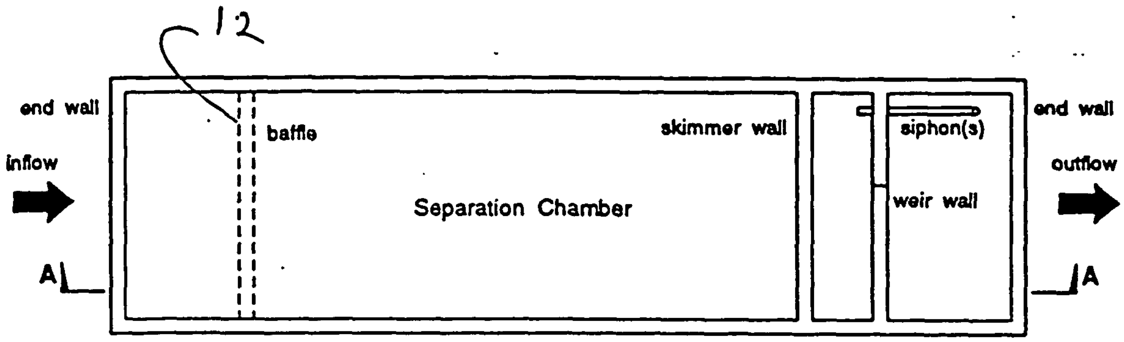
Patent Attorneys for the Applicant:

Unisearch Limited

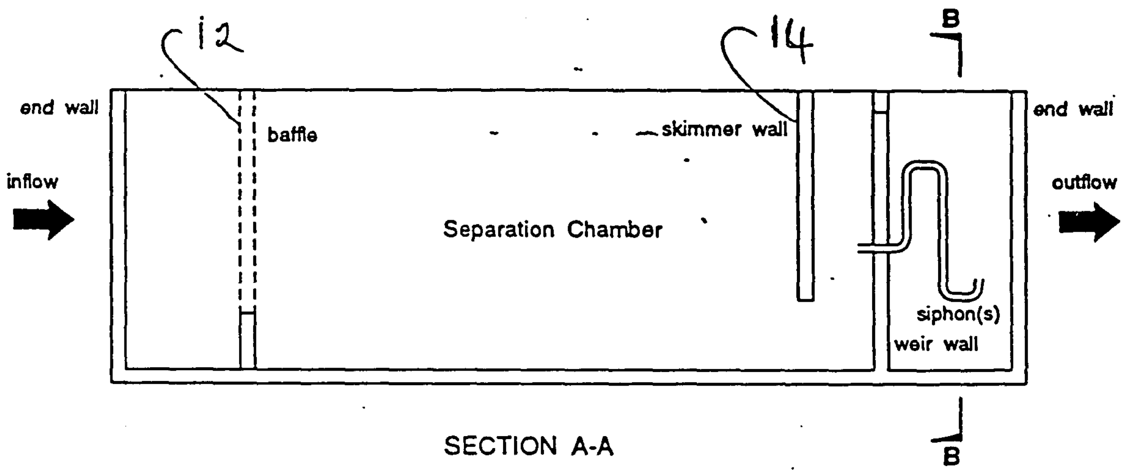


PRIOR ART

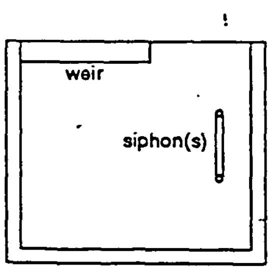
FIG. 1



PLAN



SECTION A-A



SECTION B-B

NOT TO SCALE

OIL WATER SEPARATOR

FIGURE 2

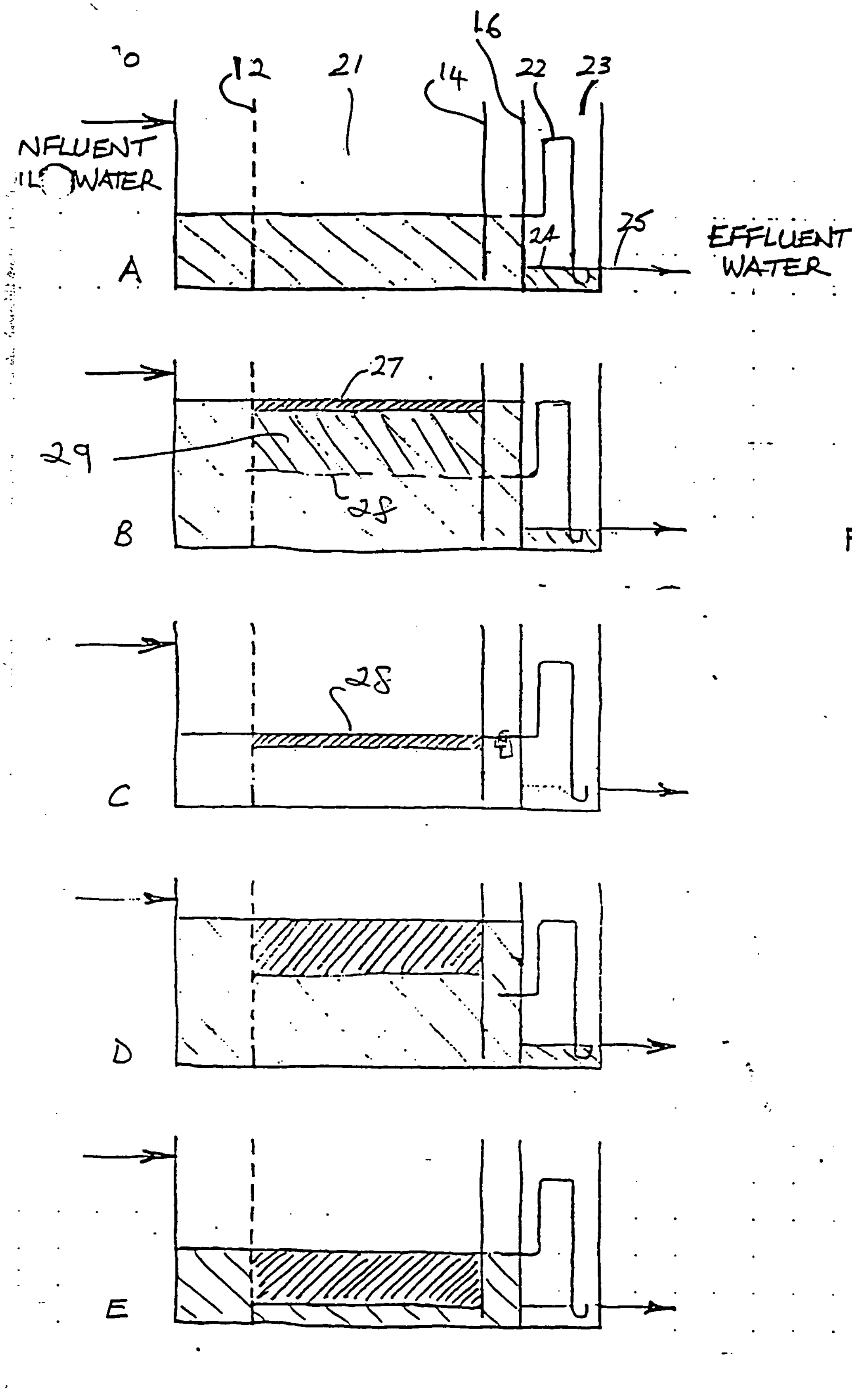


FIGURE 3

DBT 18/4/97

- WATER LEVEL VS. OUTFLOW

Fig 4.

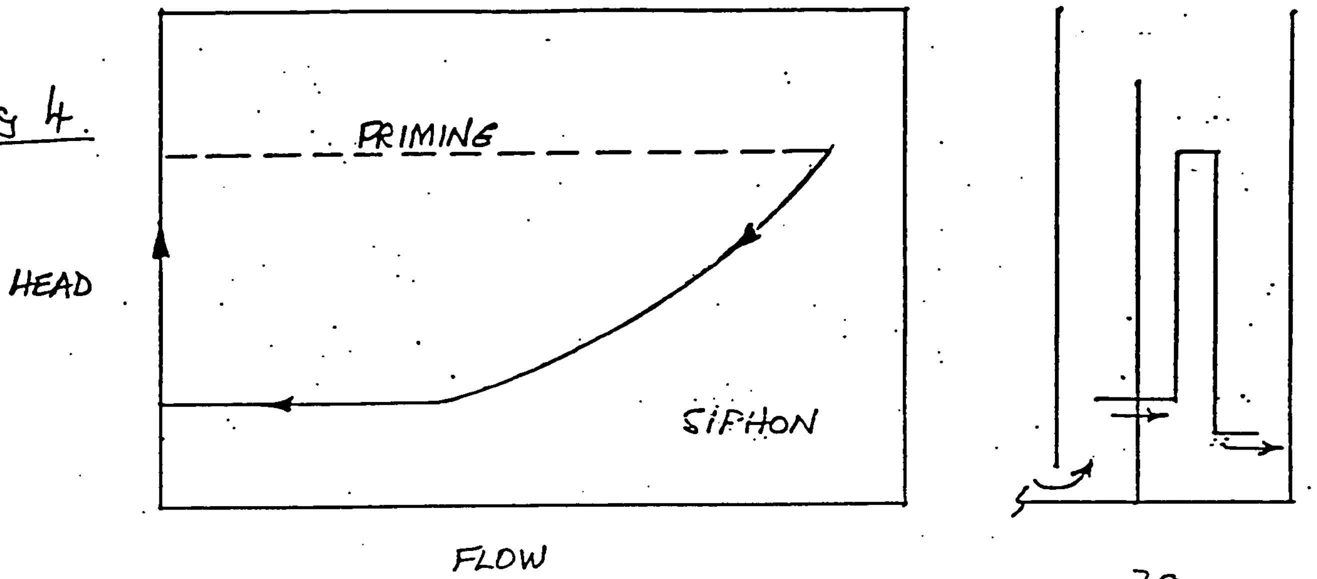


fig 5.

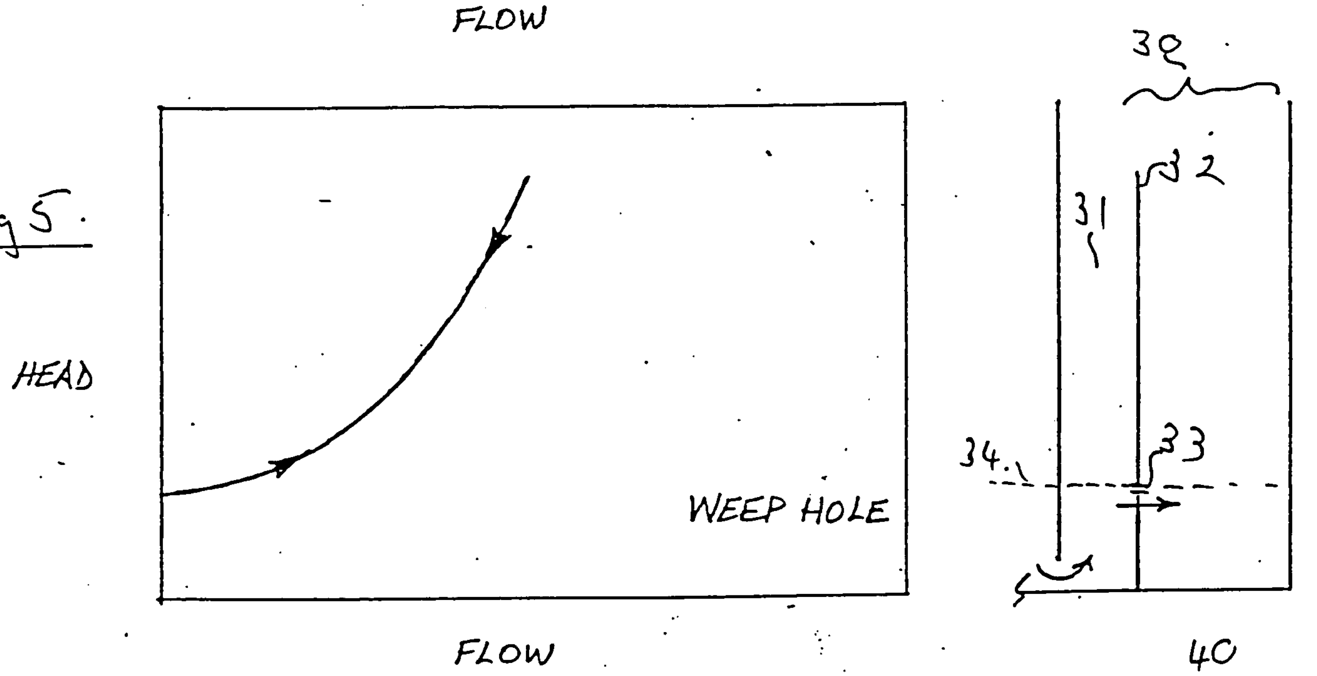
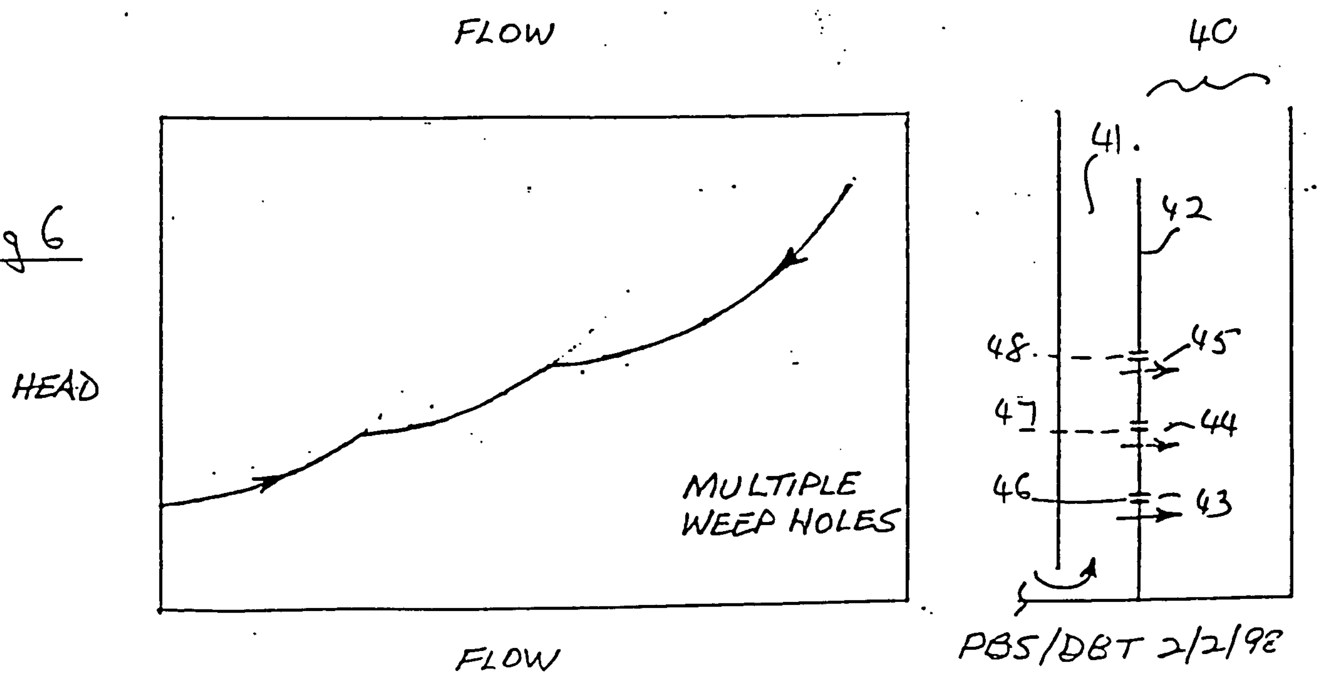


fig 6



PBS/DBT 2/2/98

— SEPARATOR WATER LEVEL DURING INFLOW EVENTS

Fig 7.

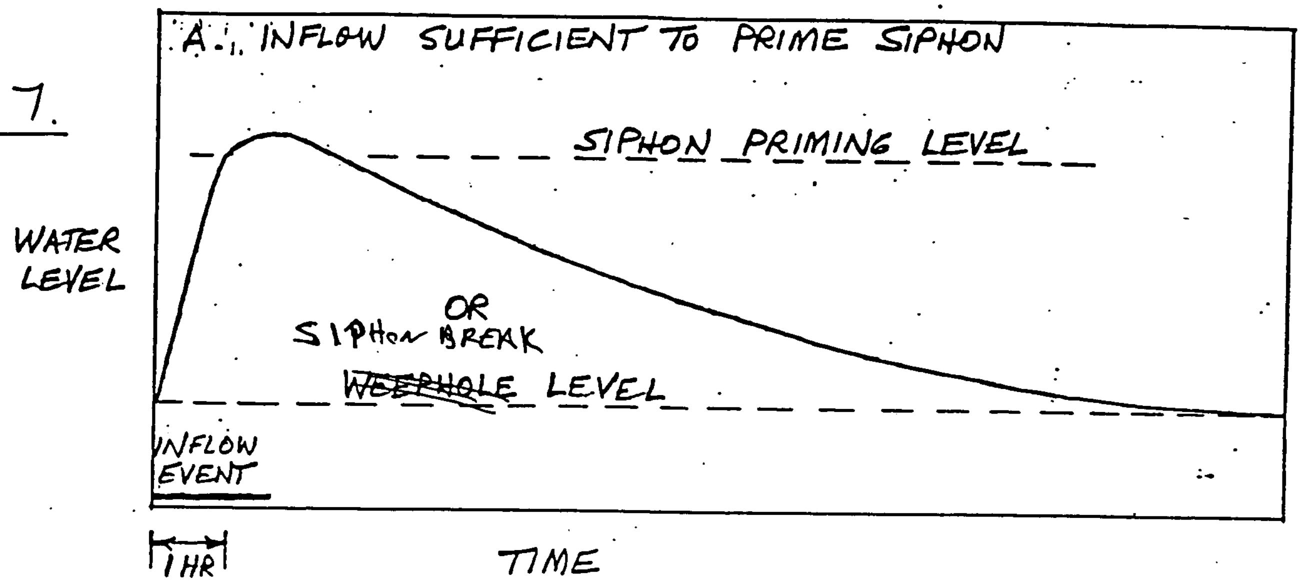


Fig 8

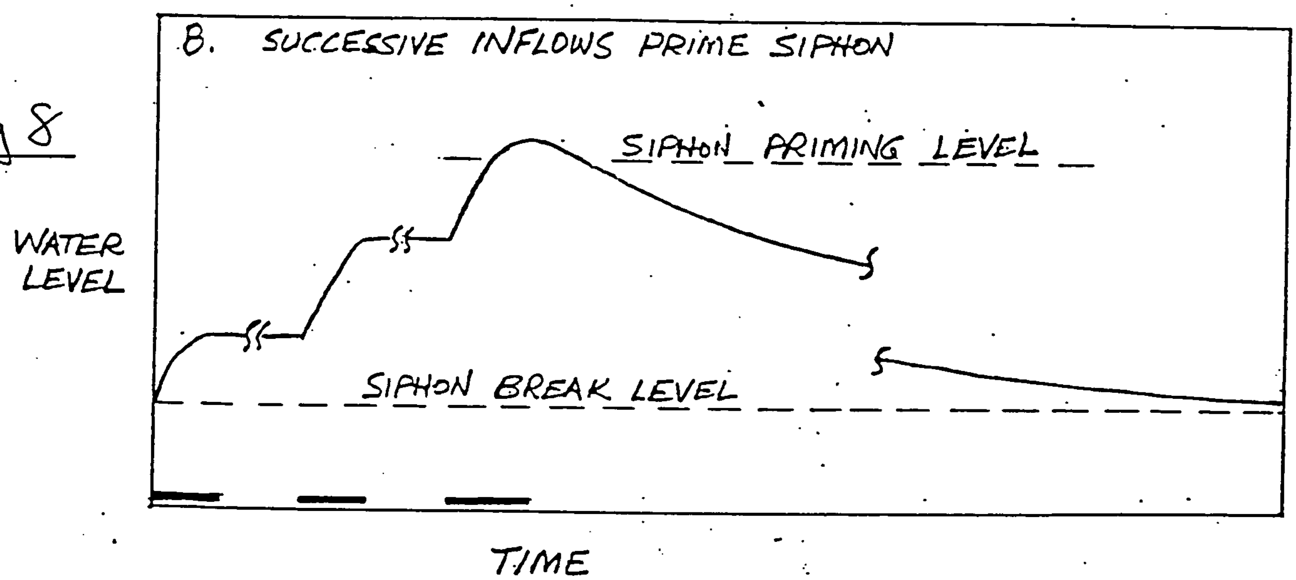
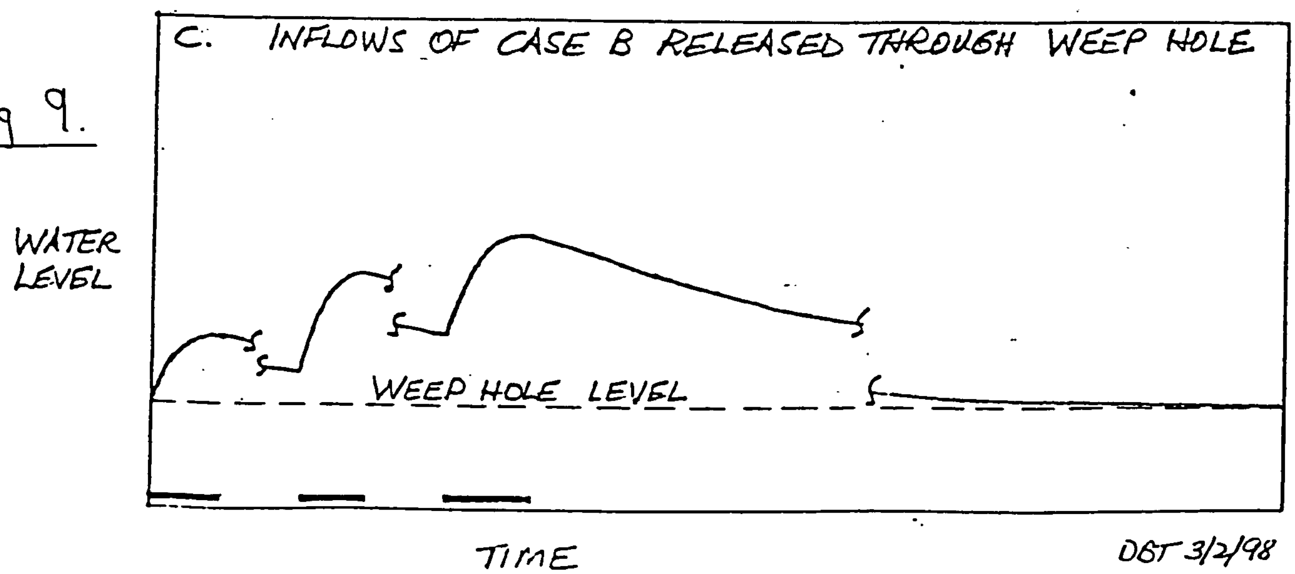


Fig 9.



DBT 3/2/98

'2 '98 12:55 ☎61[redacted]93 24 . CIVIL ENG C[redacted] 002

28-JAN-1998 13:48 FROM TO 93138624 P.02

FLOW CHARACTERISTICS

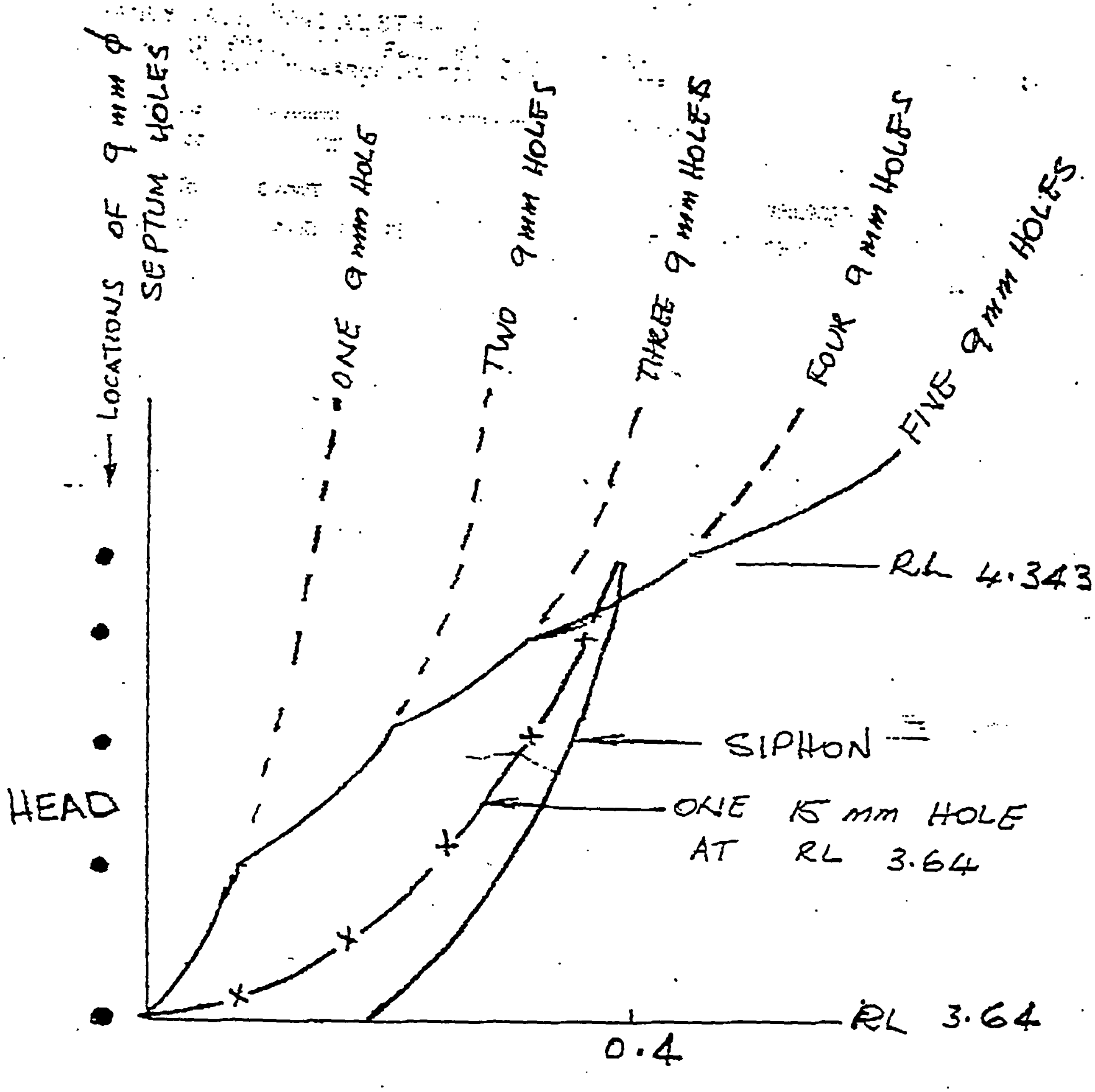


Fig 10

EXAMPLE 2. FLOW CHARACTERISTICS FOR NELSON BAY OIL-WATER SEPARATOR WITH VARIOUS FLOW RETARDING DEVICES.

PBS 28/1/98

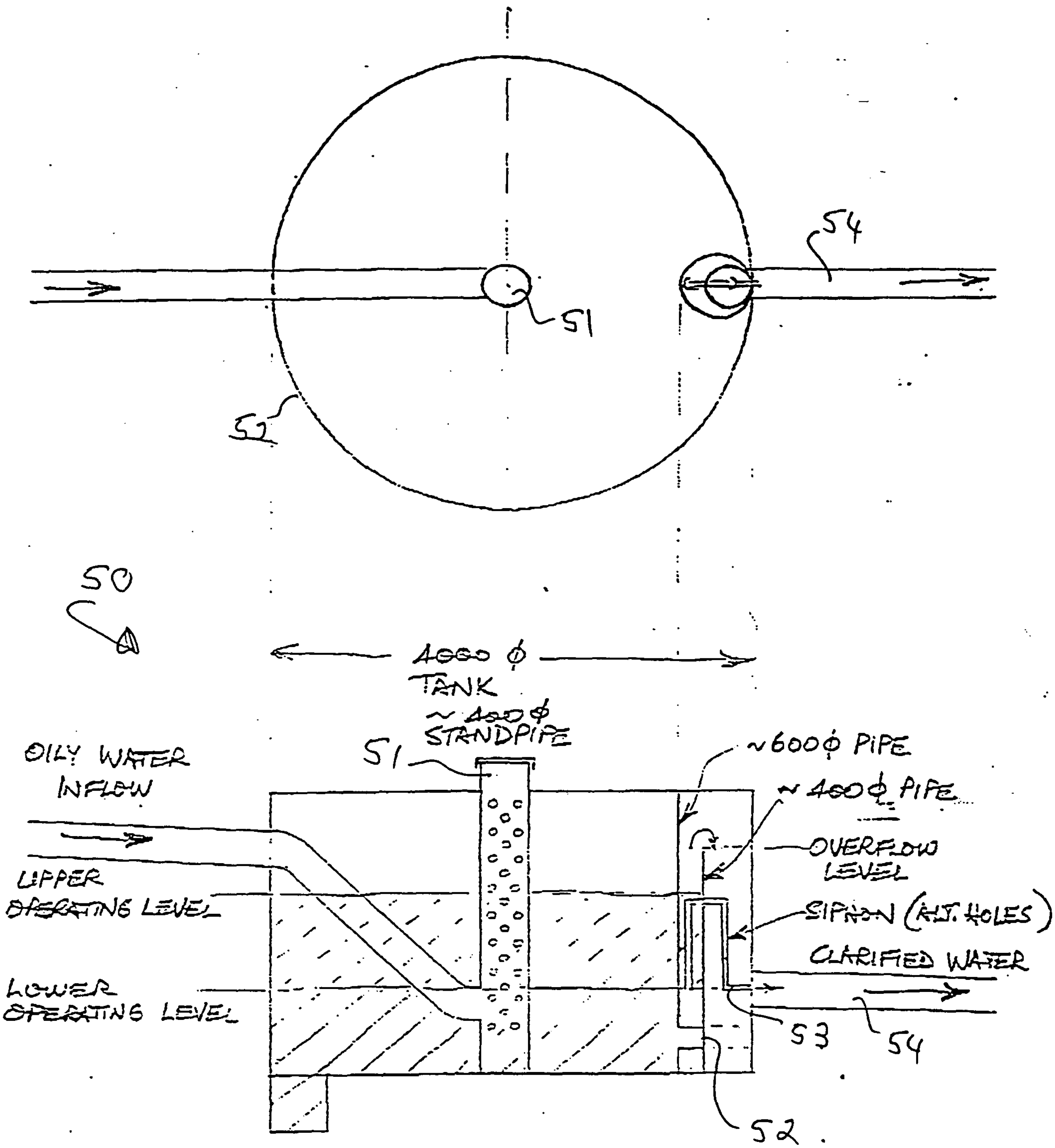


Fig 11

EXAMPLE 3. CIRCULAR LAYOUT OIL-WATER SEPARATOR

PBS/DET 14/2/98

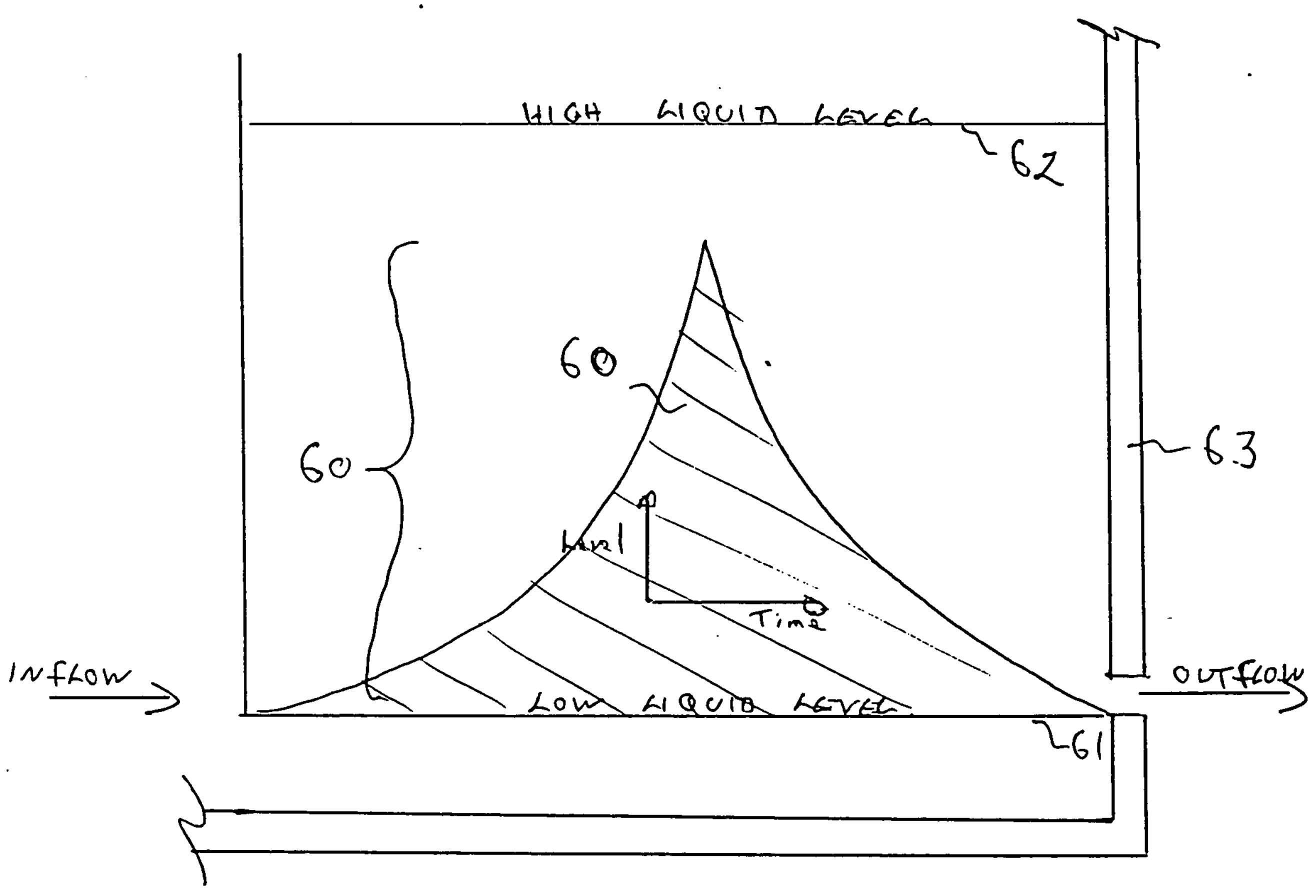

HIGH LIQUID LEVEL
62
60
60
63
Time
INFLOW
OUTFLOW
LOW LIQUID LEVEL
61

Fig. 12